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## *A NATIONAL UNIVERSITY, A NATIONAL ASSET; AN INSTRUMENTALITY FOR ADVANCED RESEARCH*[1]

### GUIDING PRINCIPLE

At the outset the guiding principle may be laid down that at Washington there is no necessity for a university of a type which exists elsewhere, no need of an additional university like the great endowed and state institutions of the country. One who advocates a national university at Washington with the idea that it shall be a larger Harvard, Yale, Columbia, Cornell or Chicago, a larger Michigan, Illinois, Wisconsin, Minnesota or California, will fail in his advocacy, because he can not give to congress a sufficient reason for the expenditure of public funds for another university of a kind of which there is a sufficient number. Not only would such an advocate be met by the above fact, but by the fact that in Germany, where universities are most highly developed, they are state, not national, institutions.

If then it is not desirable to establish a bigger Harvard at Washington, what is the aim of those who are advocating a national university? It is to make available for the advancement of knowledge the unparalleled facilities of Washington to graduate students.

At Washington are the Congressional Library, the National Museum, the Smithsonian Institution, the Geological Survey, the Bureau of Mines, the Naval Observatory, the Public Health and Marine Hospital Service, the Army and Medical Mu-

[1] Prepared for the meeting of the National Education Association, held in Chicago, July 6–12, 1912.

seum, the Office of Public Buildings and Grounds, the Board of Ordnance and Fortifications, the Bureau of Navigation, the Bureau of Education, the Weather Bureau, the Bureau of Animal Husbandry, the Bureau of Plant Industry, the Bureau of Chemistry, the Bureau of Soils, the Bureau of Entomology, the Bureau of Biological Survey, the Bureau of Corporations, the Bureau of Manufactures, the Bureau of Labor, the Bureau of the Census, the Coast and Geodetic Survey, the Bureau of Standards, the Bureau of Statistics, the Bureau of Fisheries, the Bureau of Immigration and Naturalization. In these and other bureaus and divisions are available a vastly wider variety of material for scientific research and greater collection of books and manuscripts than elsewhere exist. To enumerate in detail the facilities and materials available for work in each of the domains of knowledge would require more space than is allowed for this entire paper. Also, such a statement is rendered unnecessary because of the admirable report[2] regarding the matter by President Arthur T. Hadley, but to serve as illustrations some of the facilities for a few of the lines of knowledge are mentioned.

For the modern humanities—political science, political economy and sociology, there is a wealth of material in nearly every department. The Department of Labor, the Interstate Commerce Commission, the Census Bureau, the Bureau of Statistics, the Bureau of Pensions, the Bureau of Immigration and Naturalization and the Bureau of Corporations, are all applied divisions of political economy and political science. Nowhere else in the country is there such a mass of first-hand information regarding many of the most pressing problems for these subjects. Also the various government activities of Washington, comprising congress, the executive offices, the judiciary, and their numerous divisions and branches give illustration of practical political science on the largest scale. At Washington not only may the student of political science have the material of the subject, but also he may appreciate with what labor and difficulty results are achieved in practise.

For history, and especially the history of America, at the Congressional Library is a vast amount of material, indeed practically everything which is in printed form; not only so, but in the library is a vast collection of documents. In the State Department, the War and Navy Departments, etc., are the archives of the government since its foundation, all but a small part of which are available for the student of history.

For anthropology, the National Museum and the Bureau of Ethnology have collections and materials of the first order of importance; indeed no other collection of the country can approach them, with the exception of the American Museum of Natural History in New York.

For physics, astronomy and mathematics, there is a great mass of material in the National Observatory, in the Bureaus of the War and Navy Departments, in the Coast Survey, the Bureau of Standards, the Weather Bureau, the Patent Office and other departments.

In chemistry, there are laboratories in almost every department and bureau which deals with materials, both organic and inorganic.

For geology and its related subjects, geography, physiography and paleontology, at the Geological Survey and the National Museum is found one of the world's largest collections.

[2] "Facilities for Study and Research in the Offices of the United States Government at Washington," by Arthur Twining Hadley, Bulletin 398, U. S. Bureau of Education.

For biology, there are available the National Herbarium, the Biological Survey, the Commission of Fish and Fisheries, the botanical division of the Department of Agriculture, the National Museum and other departments.

Passing now to applied science: Almost every phase of advanced engineering work is illustrated by some division of the government. The material which would be especially available is that found in the War and Navy Departments, the Bureau of Mines, the Coast and Geodetic Survey, the Division of Architecture, the Hydrographic Office and the Land Office.

For agriculture, practically the whole department, except administration, is devoted either to the advancement of the science or to the dissemination of practical information. This great department has an appropriation for 1911 of more than $20,000,000, the larger part of which went for scientific and extension work. An enumeration of the divisions of the Department of Agriculture shows how wide is the scope of this work—the bureaus of Animal Husbandry, Plant Industry, Weather, Forest Service, Chemistry, Soils, Entomology and Biology.

While the Department of Agriculture has by far the largest appropriation for scientific work, the appropriations for scientific purposes in other divisions vary for each from more than $100,000 to more than $1,000,000.

While it would not be easy to give an accurate statement regarding the amount of money which is available in the various departments at Washington for investigation and for the tools of investigation—apparatus and books—it is safe to say that the total amounts to many millions of dollars per annum; or put in another way more than ten times as much as any single university or institution in the country for this purpose.

The vast collections of books in the Congressional Library and the large special libraries in the various departments, especially those of the Geological Survey, the Surgeon-General's Office, and the State Department, cover a greater number of fields of human knowledge with an approach to completeness than exists elsewhere in this country. These libraries are admirably administered. Expert assistants are available, so that the material on any given subject is readily secured. Not only so, but special privileges are granted in the reading rooms and in the stacks to qualified students. The facilities in these respects are incomparably beyond those of any library in other countries. It is safe to say that the collections of books in the government libraries at Washington could have an efficiency ten times as great as they now have at a small additional cost.

Manning the scientific bureaus and divisions are a scientific staff many times larger than in the largest university in the country. It is this amazing wealth of men and material at Washington that should be available for the production of scholars and investigators along many lines.

### THE DEMAND FOR IMMEDIATE RESULTS

At the present time, unfortunately, the demands for immediate results by the government compel the great staff to give by far the larger part of their energy to special problems with reference to practical ends. The rich materials from the larger point of view of the advancement of science are in large measure neglected.

### LARGE SCIENTIFIC RESULTS OBTAINABLE

If in each of the bureaus and departments mentioned there were advanced students working on the materials there exist-

ing, not with reference to the solving of particular problems which engage almost exclusively the attention of the existing staff, but with reference to the advancement of science, there can be no doubt that results of untold value would be obtained. It is believed that the utilization of this material in any bureau or department by a limited number of students need not interfere with the efficiency of the department in reaching the immediate results demanded by the government. Not only so, but it is believed that a group of advanced students, which in any department would not be very numerous, but which in Washington as a whole would aggregate a large number, could be made the means of greatly improving the work of the scientific staff of the various bureaus.

In making the statement that the bureaus at Washington yield relatively little in the way of broad scientific results, it is realized that there have been and still are some exceptions. When the United States Geological Survey was originated there were drawn to Washington the most brilliant group of geologists in the country. This survey for a number of years was the center of the world for the advancement of the science of geology; but in recent years, while the organization is vastly larger, having appropriations of millions where it had in the early days appropriations of hundreds of thousands, it is almost exclusively a department of practical geology. It is not contributing in any large way to the advancement of science.

That contributions of the Naval Observatory to science have not been large has been known for many years. In 1898 a report was made by a committee of astronomers showing that the practical duties of the Naval Observatory could be easily performed by a very small establishment. In this report it was pointed out that a national observatory is justified because astronomical observations and research might there be made which can not be accomplished at private and university observatories. The great new observatory building at Washington is splendidly equipped to carry on researches of the highest character; yet at the present time the advancement of the science of astronomy in this country is through Harvard, Yerkes, Lick, Mt. Wilson and other university and private observatories. The astronomers all agree regarding the first step necessary to remedy this situation, as does also the president of the United States and the committee on naval affairs. There should be appointed a civilian astronomer of the highest rank as director of the observatory. If this were done and the large facilities were made available to advanced students, this institution might take first place among the observatories of the world.

At the present time the advancement of science in its broader aspects is contributed to by only a few of the scientific bureaus at Washington, illustrated by the Coast and Geodetic Survey and the Bureau of Standards. On the other hand, in the universities of the country men are engaged in teaching and each year necessarily considering their subjects in the large, and immediate results are not demanded. These universities and the few independent reresearch institutions, illustrated by the Carnegie Institution of Washington and the Rockefeller Institute of New York, are the chief centers for the broader contributions to science and learning.

### THE RELATIONS OF TEACHING AND INVESTIGATION

It is my conviction, based upon many years of observation and experience, both in a university and in a department at Washington, that upon the average a man

produces the best scientific results who does some teaching. To give a course to a group of advanced students requires that a man go over the subject broadly. Even if the course be highly specialized, a man must consider his material, not only in its interrelations, but its relations to the other branches of his science. One who is a productive scholar scarcely gives a lecture upon a subject which he is investigating without illumination reaching him upon some point. There is nothing more productive of ideas than the presence and inquiries of young and earnest minds. A man who at Washington sits at his desk six days in the week, delving in his subject, often becomes buried in his material. Too frequently he never sees it from the outside. His material masters him instead of him mastering his material. The successful teacher must get outside of his subject, and consider its broader aspects.

I believe that the productivity of the scientific staff at Washington, even from the point of view of immediate results, would be improved during a given period, if each year the men of reputation were each obliged to give one set of lectures for at least a half year, either upon the subject under investigation, or some part of a science related to the investigation. The opening of the scientific bureaus at Washington to such students as are sufficiently advanced to take advantage of the material, and affording opportunity to members of the scientific staff each to give a course of lectures, would greatly improve the efficiency of the bureaus.

However, in order that the lectures may be successful, it is necessary that they be a part of the official duties of the scientific staff, not extra work for additional compensation. At the present time, because of the meager salaries, a number of men belonging in the departments give lectures in George Washington University or other institutions, thereby gaining additional compensation. This is an extremely unsatisfactory condition of affairs, in that it requires teaching to be done in addition to the day's work at the bureau. In order that lectures shall be efficient and the man who gives them gain the most inspiration and the largest broadening effect from them, they should be a part of his regular work. By the proposed combination under which a relatively small amount of instructional work would be given by any member of the scientific staff, I confidently believe that the work of the various scientific departments and bureaus, considering only the point of view of efficiency, would be greatly improved.

Thus in creating the conditions essential for the special national university which should exist at Washington, we should thereby increase the efficiency of the departments.

An incidental important gain which could come from the adoption of the plan proposed would be the training of men to fill the scientific staffs at Washington. Under present conditions, we know the staff contains many mediocre men. While this is partly due to lack of properly trained men of ability, it is realized that it is also due to niggardly pay, combined with the high cost of living at Washington. Too frequently a man who develops unusual ability in a bureau either goes to a university where he obtains better financial terms and more favorable opportunities for scientific work; or, because he can not decently support a family upon his salary, he goes into some profession or business in which he can apply the knowledge he has obtained in a department.

### THE REQUIRED MACHINERY

We now have the fundamental facts be-

fore us. Not to arrange so as to utilize to its highest efficiency the vast wealth of material for scientific research at Washington is nothing short of improvident and reckless waste of great opportunities. It is a wrong to a member of the staff to demand that he grind away at his practical problem year in and year out without giving him a chance for a larger view through instructional work.

If the above conclusions be accepted, the next question to be considered is the machinery required in order to secure these desirable ends. It may be said at the outset that for the national university here advocated, while some money must be available, no large appropriations are necessary. The institution must have an executive officer. Under him must be a staff, the duty of which shall be to learn all of the scientific possibilities of the various departments and bureaus, to advise students who come to Washington, and to arrange for their work. It should be the further duty of the administrative force to prepare announcements of the courses of instruction which are to be given, with descriptions of the material available for such courses, precisely as is done by each in the universities.

The administrative force of the national university, if desired, might be associated with the bureau of education; indeed, this would seem to be a very natural association. If this suggestion be accepted, the administrative staff and bureau of education could both be housed in a single building and such cooperation established between the two as would be to their mutual benefit.

For the above work an administration building or a part of a building is necessary. Temporary quarters should be rented, and later, when experience shows achieved results warranting the expenditure, an appropriate permanent building should be constructed. In the administration it would be necessary to provide some lecture rooms, although the halls in the National Museum and in various other public buildings should be utilized for the larger lectures. The men who give specialized courses to small groups of students probably would prefer to give them in the building in which they work; for there would be the materials and the special libraries. This would require merely that each bureau or institution, illustrated by the Naval Observatory, the Geological Survey, the Bureau of Animal Husbandry, set aside one room of moderate size for lectures.

One of the obstacles in the way of the highest success of the plan is the insufficient housing of many of the departments; but the obstacle will gradually be removed. This is evidenced by a number of exceptions. At the Congressional Library there is ample space for all the students who may desire to come. In the magnificent new National Museum, where are associated the wonderful collections in geology, mineralogy, biology, anthropology, etc., are the most ample set of workrooms and laboratories anywhere in the country. Scores of students could there readily be accommodated without interfering with the effectiveness of the staff. The Naval Observatory has a splendid new building. The Bureau of Standards has adequate quarters. All these new structures have become available within a few years, and others will undoubtedly exist within a comparatively short time.

### EXISTING LAW

Already the principles above advocated have been recognized to a certain extent by Congress through two enactments, the first in 1892 and the second in 1901.

Under these acts the scientific collections, museums and libraries of Washington and their other facilities were made accessible to scientific investigators and to advanced students, "under such rules and regulations as the heads of the departments and bureaus mentioned may prescribe."[3] Apparently the act of 1892 also contemplated that the advanced students who do work in the departments would have the assistance of the members of the scientific staff, for the preamble includes the phrase, "promote the work of education by attracting students to avail themselves of the advantages aforesaid *under the direction of competent instructors.*"

These laws have been taken advantage of to a small extent. As pointed out by President Hadley, their main service has been to men who are already trained for their work and are competent to carry on investigations independently of direction. These men have simply come to Washington and there used for their ends the material which the departments have afforded. For advanced students who still need the guidance of formal instruction the effect of these laws has been so small as to be almost negligible. Substantially the only exceptions are the one or two departments in which the scientific staff have voluntarily as a part of their duties given instruction either to the younger members of the staff in order better to fit them for their work, or to outside men. The best illustrations of this are furnished by the Bureau of Standards, the Public Health and Marine Hospital Service and the laboratories of the Bureau of Fisheries at Woods Hole and Beaufort.

### EXPLANATION OF MEAGER RESULTS

That no large results have come from the acts mentioned, one of which has been a law for more than ten years, might be regarded as evidence that the position above taken concerning the desirability of making the opportunities at Washington available for scientific work is unsound. However, it is obvious that the failure of these laws to produce marked effect is due to three reasons.

1. There is no information published describing the facilities for research at Washington and the different lines of work which may be there profitably pursued.

2. There has been available no single bureau to which application can be made for the use of the facilities, no one to guide the work of the advanced students, no one to correlate the different lines of work. It is perfectly futile to suggest that a student go to Washington, enter a bureau, tell some official that he has come to take advantage of the provisions of the laws mentioned. This a man would not do; and if he did so the chances are that he would gain very little satisfaction by so doing, for he would be lost in the mazes of the bureaucracy. As President Hadley puts it: "The student who comes to Washington to-day to get his scientific training in the government departments comes under his own impulse and at his own risk."

3. For effective advanced work it is necessary that regular instruction be given. The existing laws do now provide for such instruction. If the proposal be accepted that members of the scientific staff be permitted as a part of their duties to give a limited amount of instruction, this fundamental necessity for successful advanced work is met. In this connection it is notable that in those instances where instruction has been given by the members of the staff, illustrated by the Bureau of Standards and the Bureau of Fisheries, the facilities for advanced instruction have

[3] Anno. Fed. Stat., Vol. II., pp. 860–861 (Edward Thompson Company).

been taken advantage of. It seems to me that these cases in which important scientific results have followed systematic instruction furnish conclusive evidence that if the principles applied in these bureaus were extended to other bureaus, the facilities and opportunities would be taken advantage of upon a considerable scale, perhaps as great as their facilities permit.

Therefore, if the opportunities for scientific work at Washington were as definitely described as are the courses in the catalogue of a university, if there was a central place to which a man could go to register and be guided to his work, if he could have an opportunity to have his work correlated, if he could have the assistance of the man with whom he wished to work, then I confidently believe that there would be a very large number of students who would take advantage of the unexampled collections and libraries of Washington.

To make these facilities still more available, it would be advantageous for the various universities of the country to cooperate with the Washington authorities. In the catalogue of a university it might be well to announce the particular lines of work and the advanced courses which could be advantageously taken at Washington best to supplement the work done at the university. Such cooperation would even more clearly emphasize the fact that the plan for a national university at Washington is not one to compete with existing universities, but to supplement them. Of course, no university could be compelled to cooperate as suggested, but it can scarcely be doubted that a large number would enter into cooperation, since so doing would be to the advantage of their students. Thus it is believed that the proposals made, if adopted, will result in a great gain to science in the country and also be of direct advantage to existing universities.

It is to be noted that the plan outlined does not include that of granting degrees. The fundamental thing advocated is that the country gain the advantage of the opportunities which exist at Washington, which they may do with comparatively little additional cost. To accomplish this it is not necessary that the departments undertake the task of examinations, the approval of theses and the awarding of degrees.

If there be prejudice against calling the institution above described a national university, it may be given some other name, since as a matter of fact the institution proposed would be different from any existing university in that it would not profess to give a complete system of courses regarding any subject, but would give such specialized courses as the facilities at Washington made advantageous; and also it differs from a university in the respect that it would not grant degrees. For my own part I do not particularly care whether or not the institution of which I speak be called a national university; but I am most anxious that the great opportunities at Washington, both in the way of materials and men, shall be available as instrumentalities for advanced research, and that this shall be a national asset.

PROPOSALS APPROVED BY STATE UNIVERSITIES

The proposals made are in perfect harmony with the plan for the establishment of a national university, approved by the National Association of State Universities. In the bill introduced into Congress with the sanction of the association, it is proposed that the essential idea of the national university be opportunity for study, not the granting of degrees. It is further proposed that no student shall be permitted to work in the various departments until he

shall have had the degree of master of science or arts, or equivalent training. This would require that a man shall have his first degree and shall have pursued graduate studies for one year and thus have gone far enough in advanced work to become qualified to begin a piece of special investigation. After a student has continued his work at Washington to the point where he should have a doctorate, he may take his examination and qualify himself for his doctorate at the institution at which he previously studied, and thus add to the prestige of that institution. Naturally, a part of such qualification would be a thesis prepared by using the material in the bureaus and departments. If the universities outside of Washington should cooperate with the Washington scientific staff, a student at Washington might be to a certain extent under the guidance of the university from which he came, and by this means his entire graduate work be made a harmonious whole.

### NOT A RIVAL TO EXISTING INSTITUTIONS

Thus the proposed national university would not be a rival to existing institutions, but supplementary to them; not supplementary to one of them, but supplementary to all. In Germany it is the habit of students when studying for a doctorate to spend a part of the time at one university and a part at another. In some cases the work for the doctorate may be done at more than two institutions. The plan to have the departments at Washington available for advanced work would undoubtedly result in giving to many students a broader training than they now secure because of the fact that they would do a portion of their advanced work in a university and a part in the research departments at Washington. This arrangement would be most advantageous, for a part of the work would be done in institutions where the spirit is that of a university, and part in the bureaus where the spirit is that of immediate results; and it is the combination of the ideal and the practical in a man's education which gives the highest capacity for future useful service to the nation.

### SUMMARY

In summary, (1) It is proposed that the unapproached wealth of books and materials at Washington for research be made available to the advanced students of the country having the baccalaureate degree and one year of graduate work or its equivalent.

(2) It is proposed that the scientific staff at Washington be authorized as a part of their official duties to give a limited amount of instruction.

(3) It is proposed to establish an administrative division, the duties of which shall be to make the facilities of Washington known and to guide the students to them. If desirable this division may be made a part of the Bureau of Education.

(4) It is proposed that a student completing his work for a doctorate at Washington be granted his degree from the institution from which he came.

(5) It is proposed that existing universities cooperate in this work with the departments at Washington.

If this plan be adopted, it can not be gainsaid that science in America will receive a great impetus; that the scientific bureaus at Washington will be inspired to escape from their bureaucratic bonds at least in some measure, and if so they will make larger contributions than heretofore to the advancement of learning. All the above results may be accomplished by a relatively small expense and to the mutual advantage of the United States departments and existing universities.

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## THE NATIONAL UNIVERSITY[1]

I HAVE been asked to make an address upon the relation of the National Association of State University Presidents to the movement for the establishment of a national university.

I desire to say in the first place that, apart from the facts which I shall give concerning the action of the association, I shall be presenting my own ideas. I believe they represent fairly well those of my colleagues in the association, and yet as they have not been presented to them for their criticism or endorsement, I wish it to be distinctly understood that I am speaking for nobody but myself in the argument which I shall present on this subject.

After the fullest and most careful discussion of all phases of the subject the National Association of State University Presidents has repeatedly endorsed the project for the establishment of a national university.

This means a university established by the federal government of the United States, deriving its support primarily from the federal treasury, subject to the ordinary control which a free government exercises over its organizations and their work.

I desire to lay down two or three propositions which seem to me fundamental in securing a proper position from which to judge this whole question. My first proposition is, that in a free state education is fundamentally a national function. I do not mean by this that it is necessary for the federal government of such a free state to regulate, control or support education; though it may be desirable that it should do so. If the locality or the state, or the two together, in a country like ours, will provide adequately for this national function, it may be properly enough left to them; but if they either do not or will not provide for it, then the federal government itself should undertake to see that provision is made. I mean, therefore, that education is a national function in the sense that it is of fundamental importance to the nation as a whole; that it should be properly performed, and if there is no other way to secure its proper performance except through the cooperation of the federal government, then we should have this cooperation.

I maintain that in a state like ours, education is a national function; because to the permanent endurance of a republic, popular education is an absolute necessity, and if it can not be obtained by one form of governmental organization, then it must be obtained by another, or the nation will suffer the consequences. No free government can long exist which is based upon an illiterate people—nay, I believe we may properly paraphrase Lincoln's great expression on another subject, that this government can not remain permanently free if it is based upon a population half literate and half illiterate. All the people must become educated to the necessary extent to secure the basis for democratic government, or in a certain sense, all will become uneducated, *i. e.*, the value of the educated half will be largely lost, *i. e.*, will fail to secure that degree of education necessary for the preservation of a free state. Now that is a national function, to my mind, in its nature, the adequate performance of which is essential to the existence of a nation. From this point of view, education, after the national defense, is the most distinctly national function of all the functions which our society has to perform.

But education is national in its nature

[1] Abstract of an address delivered before the National Education Association at Chicago, July 8, 1912.

from another point of view and should be recognized as such in the organization of our government. The advantages given by elementary and secondary and higher schools are not limited to the communities which support them. A little red school house upon a lonely hillside of a New England state may train the man who will head a great movement for reform and progress in a distant state beyond the Rocky Mountains. The people of the latter state profit by the education which that man obtained at the expense of that New England district, and they should, by all standards of fairness, contribute their part toward the support of the school which produced him. In fact, I think it is not too much to say that, taken broadly, the history of this country during the last two generations demonstrates that in many cases the chief advantage of the school system of a community has redounded to the benefit of other communities in which the particular boys and girls educated in these community schools have subsequently spent their lives and done their work as members of society. Now if all sections of the country profit by the existence of educational advantages in any one community, so the country and the nation, as a whole, should be expected to do its part in developing and supporting these local facilities for education.

There is another reason why education is in its nature a national and not a local or state function, and that is that the disadvantages of the lack of facilities and the lack of schools are not limited to the communities which suffer such lack of school facilities to exist. You hear a man say sometimes that it is up to the community to keep its school, and if it doesn't wish to keep one, let it suffer the consequences. But the same thing is true here as in the case just mentioned, the evil results of inadequate school facilities do not accrue alone to the communities which neglect such matters, but are liable to be of the most serious consequence to other and distant communities; because under our scheme of life, the ebb and flow of our population is so continuous and so extensive that the boys and girls who have missed the opportunity for the highest development, owing to the lack of these local facilities, become members of other communities and go into them and into their work weighted down with all the ignorance and apathy and indifference to higher things which is characteristic of an ignorant population as a whole. So that alike by the distribution of its advantages and the distribution of its disadvantages, popular education is in its nature a national function and not merely a state and local function, and consequently, unless the locality and the state can and will perform this function satisfactorily, the nation must come in as a unit and through its organized representative, the federal government, contribute its share in this way to the support of this common institution.

We must not lose sight of the fact that it is, after all, the American people, as a whole, that pays the bills. It is not the nation distinct from the state or the state distinct from the locality; but it is the locality and the state taken in their totality which make up the nation; and it is therefore a mere question of expediency through what organ and to what extent the people will exercise their power for the purpose of promoting the public welfare.

Now there is another important reason why the people of the United States should aid the cause of education through their federal government as well as through their state and local government, and that is that the people, as a whole, can do certain things through the cooperation of

their federal government which they can not do through their state government or through their local government alone. The expense of an adequate educational system is enormous, and grows continually with the rising standard of the people as to what satisfactory education is. An adequate revenue system will draw upon national sources of revenue through the federal government, upon state sources of revenue through the state, upon local sources of revenue through local government. Some sources of wealth may be more easily and efficiently tapped through the federal government than through the state or local government, and *vice versa*.

In our scheme of federal government in this country, we handed over to the central authority a revenue power—I will not say more than adequate for the federal purposes which we incorporated in our constitution, but I will say more adequate to accomplish the national ends contemplated in the law than were given either to the state or the locality. The federal government can raise funds in many respects more easily than either the state or the locality. And a sound financial system demands that that element in our system shall raise the revenue which it can raise most easily, and then that a reasonable distribution of the revenue so raised among the various federal functions and among the state and local functions shall be made.

I think our history has demonstrated clearly enough already that education can never be properly cared for in this country unless we draw upon national sources of revenue as a means of assisting in its support.

Owing to history which I need not recount, the southern states, for example, find themselves in the position of having two independent and complete systems of education, for the white and colored races, respectively. It is quite unreasonable to hope that in our day and generation the southern communities will be wealthy enough, or, what amounts to the same thing for our purpose, will think they are wealthy enough, to care adequately for these great interests, and if the people will not utilize their other sources of revenue and their other organs of government to assist in providing a part of the means for the solution of this problem, we shall still continue to suffer as we have suffered for generations by this situation.

My next proposition is that this country can not solve its educational problems in the large until it recognizes that education is the business of the nation and that pecuniary assistance for its support in a large way shall come through the organs of the nation as a unit.

We can not get the money in any other way. We refer, of course, by preference in our educational discussions to the unhappy educational conditions of certain portions of the South. But the conditions are just as really and just as truly inadequate over whole sections of the northern states as they are in the south. We need not go out of the state of Illinois itself to find schools which do not deserve that name. We need not go outside of Illinois to find local communities which, after taxing themselves to the limit which the law allows, still have not sufficient money to maintain, during the months in which a child ought to be in school, the kind of school which it is worth the child's while to attend.

There is another important matter which we ought not to lose sight of. Great national issues are pushed forward only when it is possible to secure national attention for them; only when they have become national in a formal as well as an informal way; only when the nation is

discussing them as great national issues. If we could get national attention concentrated upon our educational problems year after year as one of the fundamental issues going to the very life of the nation itself, we should make vastly greater progress than we do. And this attention we shall get when we recognize the essentially national character of education by making educational policy a part of national policy. When the federal congress discusses educational questions as fully, as completely, as they discuss questions of defense and the tariff and internal improvements, we shall be in a way of securing for educational issues that attention which is necessary to their continuous and rapid solution.

Intimately connected with this fact, namely, the necessity of securing national attention for the consideration of national problems, if we wish to hasten their solution, is the further one that we could advance with far greater certainty and with far greater speed, our national standards, *i. e.*, the standards of the people taken as a whole and in their local organizations, if we can get before the nation, as a whole, a proper standard of what education means and what education ought to mean.

The nation then, and not merely the local school district or community or state, must become an educational unit in all grades of education.

It has already become so to a certain extent. It is becoming so more and more every passing day. Unequally, it is true—in spots only—here and there, but steadily and persistently. The federal government has granted lands for the support of elementary education in nearly all the states of the union within whose territory were to be found large stretches of government-owned land. In fact the federal grants were the foundations of the school funds in the vast majority of the states of the union. But the federal government has not been content with this. It began some fifty years ago the policy of developing within each state in the union a higher institution of learning supported in large part, first by federal grants of land; second, by the grants of money realized from the sale of lands; and finally, by grants of money raised by the general revenue system of the government. To-day we have sixty-seven such institutions which owe a part, or the whole, of their income to the action of the federal government. The aggregate value of the permanent funds and equipment of these land grant colleges themselves exceeds to-day $125,000,000. The total income of these institutions in 1910 was nearly $23,000,000. It would take an endowment fund of over $450,000,000 to produce this income.

We take pride here in Illinois in the fact that it was an Illinois farmer and professor who first formulated this plan, and that the legislature of Illinois was the first American legislature to stand strongly behind this policy of federal grants to higher education within the states. It has become the greatest scheme of an educational endowment which the world has ever seen. The federal government itself contributes only a small part of the total funds necessary for the support of these institutions, but it was the giving of that small part which made the rest of it possible, which stimulated local and state interest, which by fixing national standards stimulated the nation to rise to these standards. I have very little doubt myself that if it had not been for the action of the federal government in making these appropriations for the development of agriculture and the mechanic arts within the states, we should be a whole generation behind what we are

in the development of our educational system.

Incidentally, I may say that the House of Representatives of the Illinois legislature has again led the way in urging upon the federal government the necessity of large additional grants for educational purposes by sending to congress a unanimous petition, as follows:

WHEREAS, The legislature of Illinois by the joint resolution of February 8, 1853, was the first among the American legislatures to petition the congress of the United States to make a grant of public land for each state in the union for the liberal endowment of a system of industrial universities, one in each state, to promote the more liberal and practical education of our industrial classes and their teachers; and,

WHEREAS, The congress not only made a liberal grant of land in the year 1862 for this purpose, but has also followed up this policy once begun by still more liberal appropriations for the support of higher education in agriculture and the mechanic arts, resulting in the great chain of colleges for agriculture and the mechanic arts to be found in every state and territory in the union; and,

WHEREAS, The time has now come for the adoption of a similar policy in the field of elementary and secondary education; therefore, be it

*Resolved*, By the house of representatives of the state of Illinois, the senate concurring herein, That the congress of the United States be respectfully petitioned to appropriate annually to each state and territory in the union a sum equal to one dollar per head of the population of said state or territory as ascertained by the last census, for the purpose of establishing, maintaining and extending in the elementary and secondary schools of said states and territories, while not excluding other elementary and secondary subjects, such practical, industrial and vocational training, including agriculture, the mechanic arts, domestic science, manual training, commercial subjects and such instruction in other similar subjects of practical nature as the interests of the community may seem to demand; and

*Resolved Further*, That our senators in congress be instructed and our representatives be requested to use their best exertions to procure the passage of a law of congress donating said sum to each state and territory in the union for said purpose; and

*Resolved Further*, That the governor of this state is hereby requested to forward a copy of the foregoing resolutions to our senators and representatives in congress and to the executives and legislatures of each of the other states and territories, inviting them to cooperate with us in this meritorious enterprise.

I wish to emphasize again very strongly that national aid to education, whether lower or higher, does not necessarily mean excessive federal centralization and control. The extent to which the federal government shall have control of the funds which it devotes to education is a matter of expediency to be settled from time to time and from generation to generation, as national and local needs and possibilities may dictate.

I should like to call attention to one other fact, and that is that the federal government, when it wished to develop, by the expenditure of a comparatively small sum of money, a system of educational institutions which should have a profound effect upon the development of elementary and secondary education, it chose to establish colleges, not high schools; colleges, not grade schools; colleges, not kindergartens. In other words, it recognized that in the development of any educational system in a country, progress goes often from the so-called higher to the lower. You can not develop a good high-school system unless you have a good college system which can supply the necessary teachers, the necessary guidance, the necessary stimulation, the necessary leadership. You can not have good grade schools unless you have good high schools which furnish, taken as a whole, the training of the teachers employed in these elementary schools. The converse is, of course, equally true, that you can not develop your college beyond a certain low level of efficiency unless the high schools can be brought up to a high level. Nor can you raise the level of your

high schools to what it ought to be unless the grade work is done properly.

I desire again to call attention to the importance to educational advance of securing a national formulation, a national organization of the educational idea and educational ideal.

There is a subtle moral and psychological reaction upon the people, as a whole, arising from the formulation and incorporation of a national ideal in a practical national policy which spells progress and success for movements which are able to find such national expression.

As suggested above, when education is as regularly the subject of national debate and national conflict as the tariff, banking and currency and internal improvements, we shall take another long step forward in our educational development.

What I have thus far said applies to all grades of education alike, and it is upon this foundation that in my advocacy of a national university I take my stand. If the views thus far advanced command your assent, I believe I shall have your consent to the further proposition I advance, namely, that one of the essential elements of our American system of education is the kind of a university which the federal government can build and which shall stand, so to speak, at the apex of our educational pyramid, or if you choose to reverse the simile, it is all one to me—which shall be the foundation stone upon which the pyramid of national education shall be erected; for all history shows that from the universities, from the highest schools, have gone forth steadily those influences which have molded and shaped and fashioned the popular education in all times and in all countries.

I mean by a national university, an institution sufficiently like the ordinary institutions with which you are all acquainted to be thoroughly familiar to you. A teaching and training, as well as an investigative institution, manned with the best men in all departments in which the human intellect has exercised itself, drawn from the entire world, equipped with all that money can provide, for the purpose of stimulating and increasing our interest in the world of the spirit and the world of sense about us.

Now one of the fundamental purposes of a university system is to beget, diffuse and establish, in the mind—nay, I will say also in the heart of the people, the scientific spirit and the scientific method. If this can be accomplished, the face of the world will be changed. Now this can be done in certain respects more easily and more thoroughly and more rapidly by means of a system of state and national universities than by any other means.

In what I am about to say I am not animated by any spirit of opposition to the historic, private institutions of this country. He would be an ungrateful American indeed who would cast any slur upon Harvard and Yale and Princeton and the scores of more recently founded private universities, like Hopkins, Chicago and Leland Stanford and Northwestern, which are such an honor to our country and our civilization. I should certainly consider myself an ingrate if I should say anything derogatory of Harvard or Pennsylvania or Chicago or Northwestern, where as student or professor or president I had an opportunity to prepare myself for public service, and to have had some small part in the glorious work of these institutions. All honor to them, and increasing power and glory and prosperity! But, friends, however great they may become—and may their shadow never grow less—they can never accomplish the purposes we have here in mind, namely, to incorporate in a

visible form the national ideal of university education.

I have long been a warm admirer of President Eliot, in many respects the greatest figure in American education. He was kind to me personally when I was a freshman at Harvard. He was for more than a generation my guide, philosopher and friend in the field of university education and administration. I think it is not too much to say that he revolutionized it to its great betterment.

But I know no more striking illustration of the fundamental weakness that doth beset us all, than President Eliot's notion that he could make of Harvard a national university in the sense that we have been using the term here. That he could make a private institution, dependent for its resources upon the liberality and self sacrifice of alumni, however generous they may be, or upon the whims of rich men, however numerous they may be, situated upon the edge of the country, even though in such a glorious city as Boston, that he could make an institution so located, and so fathered and mothered to be that embodiment of our national ideal of science and education and art which we are looking for. Other men have or have had the same notion for their institutions. Idle and vain hope! Neither Harvard nor Yale nor Columbia nor Princeton, nor all of them taken together, great as is their function, great as is their service, can hope to do this particular service for this country. Nor Mr. Rockefeller nor Mr. Carnegie nor both of them together, though multiplied by five and animated even still more fully than at present by patriotic unselfishness and far-sighted motives, can do this thing for the nation which, after all, only the nation can do for itself. The state universities of Michigan and Wisconsin and Minnesota and Illinois and the forty others—no one of them alone nor all of them together, great as they may become—and we are all headed for great things—can hope to fill this place, incorporating in themselves, in such a way as to satisfy the national longing, that deep-felt, that unexpressed ideal of university education.

The reason is simple. No partial expression will satisfy this longing for wholeness. When that which is perfect shall have come, that which is imperfect will unite with it and help constitute its perfection—private and state institution, with the national university—making one complete system, or it will dry up and disappear. When that which is complete shall have appeared, that which is incomplete must become a part of it or be sloughed off or cast into the scrap heap. No national university can exist except as the creation and organ of the national will, shaped and directed by it. Supported and sustained by this national will, it will be the expression of you and me and all of us, we a part of it and it of us.

Such an institution would not injure, but benefit every private and every state university, by its superior support, by its superior prestige, by its greater wealth. It would strike the popular imagination of this country in such a way as to give to the university idea itself an enormous impetus, the reflex effect of which would show itself in the increasing prosperity and development of every private and state institution.

The foundation of Leland Stanford did not injure the University of California, but helped it immensely. The foundation of the University of Chicago did not injure Illinois or Northwestern or Michigan or Wisconsin, but by the bold and striking way in which it raised high aloft the standard of science it gave an impetus to the university idea which made the work of

every one of these institutions more adequate and more easy.

The same thing would be true in a larger degree of a national university, organized along proper lines, and put under proper influence.

Such a national university as I have suggested, located at the site of the federal government, supported by appropriations from the federal treasury, controlled and regulated by federal law, would easily become, as it ought, the crowning institution of our university system, private and state alike. It could supplement the shortcomings of our other institutions as well as emphasize their excellencies. It could undertake many enterprises of national scope, and which no existing single institution, public or private, can afford to undertake. It could offer to our best qualified young men and young women, opportunities which only a nation like ours can afford to offer.

Such an institution, located in the national capital, would exercise a vigorous and salutary influence on the course of federal legislation itself. Its pointed spires and gilded domes would of themselves be powerful, though mute, monitors calling attention to the claims of science to be the guide of legislations.

Such an institution located in the center of political power of the greatest nation on earth would attract in large numbers the bright and promising youth of other countries, who, as students here, would imbibe those fundamental American ideas which we fondly believe are destined to work out the salvation of the world when they shall have done their perfect work, while these youth would gain added respect for our society and our ideals, which, carried back home and incorporated in their own policies, would contribute powerfully to that mutual understanding which is the surest basis for international peace.

Such an institution located in Washington could utilize for purposes of instruction and investigation the wonderful resources heaped up by the government of the United States in its scientific departments. The National Library, the museums and collections of all sorts lie largely fallow at present, waiting for the people of the United States to make their utilization possible in the various schools and colleges of a national university.

Such an institution, located at such a strategic point, will wield a subtle, ever deepening and widening influence over the whole American people in the direction of increasing their interest in science and their belief that science is an important element in private and national life. It will be their university, and they will come to take an increasing pride in, and appreciation for, the work it is doing; and thus will, by this reflex effect, be trained to gradually entertain an ever deeper respect for the standards and ideals of higher education itself.

Friends, such an institution is coming, as surely and irresistibly as the tides of ocean. Will you help it, or will you oppose it, or, worse than either, will you do nothing?

This National Education Association could secure the establishment of this institution in a short time if it would only go after it in earnest.

Ignorance and apathy and prejudice have thus far been most potent in preventing the realization of this dream of Washington.

Private institutions, religious and secular, have opposed, thus far successfully, the movement. Private institutions, men of wealth, men of no wealth, men of ideas, men of no ideas, have set themselves against this project. It is up to you and the like of you to help bring this about in our day and generation.

This great power can be set to work immediately in the interests of science and art and education, supplementing, reinforcing our defective and weak system of education. Every day its coming is delayed represents so much pure loss to the causes in which you are interested; to the welfare of this nation, and to civilization in general by all that it might contribute if it were now at work.

This institution, this national university, would be one of the most important elements in making this nation of ours in reality what it is in our dreams and hopes and fond anticipations, the leader of the world in art, in science and education, and in civilization.

EDMUND J. JAMES
UNIVERSITY OF ILLINOIS

## SCIENTIFIC NOTES AND NEWS

DR. ANTON FRITSCH, director of the zoological and paleontological division of the Museum at Prague, has celebrated his eightieth birthday.

SIR WILLIAM RAMSAY has been elected a foreign associate of the Paris Academy of Medicine.

DR. A. ENGLER, professor of botany in the University of Berlin, has been elected a corresponding member of the Paris Academy of Sciences.

GEORGE AMOS DORSEY, associate professor of anthropology in the University of Chicago, who has recently returned from a three years' tour of the world and investigations in his special field of research, was given a banquet in Chicago on July 30 by the directors of the Chicago Geographical Society, of which Dr. Dorsey was at one time president.

DR. JOHN K. SMALL, head curator of the museums and herbarium of the New York Botanical Garden, was given the honorary degree of doctor of science at the one hundred and twenty-fifth anniversary of Franklin College, Lancaster, Pa., on June 13.

DR. D. H. SCOTT, president of the Linnean Society of London, has been elected a foreign member of the Academy of Sciences at Copenhagen.

SIR PATRICK MANSON has retired from the position of medical adviser to the Colonial Office, and has been appointed a Knight Grand Cross of the Order of St. Michael and St. George in recognition of his eminent services in connection with the investigation of the cause and cure of tropical disease.

THE Moxon gold medal for research in clinical medicine has been awarded by the Royal College of Physicians, London, to Sir David Ferrier, F.R.S., and the Murchison memorial scholarship, founded in memory of Dr. Charles Murchison, has been awarded to Dr. W. Rees Thomas.

DR. JOSEPH H. WHITE, of the United States Public Health and Marine Hospital Service, has been asked to become a member of the Boston board of health to act as an expert in the health department.

AT the recent annual meeting of the Imperial Cancer Research Fund in London Dr. William H. Woglom, of Brooklyn, was appointed first assistant in New York, a position maintained under the Crocker Fund for the Investigation of Cancer. Dr. Woglom was sent to London by the directorate of the Crocker Fund to pursue a course of studies under Dr. Bashford, director of the Cancer Research Fund.

DR. EDGAR W. OLIVE, professor of botany in the State College of South Dakota, has been appointed curator in the Brooklyn Botanic Garden.

MR. HERBERT E. IVES has resigned his position in the Physical Laboratory of the National Electric Lamp Association in Cleveland to accept the position of physicist of the United Gas Improvement Company of Philadelphia, where his work will consist of consultation and research in connection with the measurement and utilization of heat and light.

MR. E. H. TENNYSON D'EYNCOURT has been appointed director of naval construction to

the British Admiralty, Mr. W. J. Berry becomes assistant director and Sir Philip Watts is to be retained as adviser on naval construction.

We learn from *Nature* that Professor L. E. Bouvier, of the Jardin des Plantes, has been appointed "Ray Lankester Investigator" for 1912–13, and will occupy the Ray Lankester table in the laboratory of the Marine Biological Association at Plymouth. At the request of the trustees, the nomination for this first appointment was made by Sir E. Ray Lankester, K.C.B., F.R.S.

Dr. Irwin Shepard, of Winona, Minn., for many years secretary of the National Educational Association, has resigned.

Edwin Brant Frost, professor of astrophysics in the University of Chicago and director of the Yerkes Observatory at William Bay, Wisconsin, has been granted leave of absence for a year by the trustees of the university.

Professor J. C. Arthur and Dr. F. D. Kern, of Purdue University, Lafayette, Ind., are spending July and August studying the plant rusts of Colorado, especially along the lines of the Denver and Rio Grande Railway in the southern half of the state, where the problems of association and distribution of species are unusually well presented.

Dr. E. B. Copeland, dean of the College of Agriculture, Los Baños, P. I., who has been visiting the United States, returned to the Philippines at the end of August.

Commander Evans, R.N., of the British Antarctic Expedition, has left England for New Zealand, where he will resume command of the *Terra Nova*, which will proceed to the south polar regions to meet Captain Scott and his party.

Professor C. Juday, of the University of Wisconsin, gave two lectures on the physics and chemistry of lake waters and their biological significance during the latter part of July, at the Indiana University Biological Station, Winona Lake, Indiana.

Dr. Guy Montrose Whipple, of the School of Education, Cornell University, has given three lectures on "The Training of Memory," "The Psychology of the Marking System" and "The Supernormal Child" at the summer session of the University of Illinois.

Professor Eugene Lamb Richards, emeritus professor of mathematics of Yale University, died on August 5, aged seventy-four years.

Dr. Maurice Howe Richardson, Moseley professor of surgery at Harvard University, died on July 31, aged sixty-one years.

The deaths are also announced of Professor Edmund von Neusser, known for his work on internal diseases, at Vienna, and of Dr. Monoyer formerly professor of ophthalmology in the faculty of medicine of the University of Lyons.

The United States Civil Service Commission invites attention to the regular fall examinations for scientific assistants in the Department of Agriculture, to be held October 16–17, 1912. Examinations will be given in the following subjects: Agronomy, dairying, entomology, farm management, forage crops, horticulture, library science, nutrition of man and calorimetry, plant breeding, plant pathology, pomology, seed testing, soil bacteriology, soil chemistry, soil surveying. The commission also announces examinations on September 4, to fill vacancies in the dairy division of the Bureau of Animal Industry, Department of Agriculture, in the positions of assistant dairymen, qualified respectively in market milk investigations, dairy farming and butter making, at salaries of from $1,500 to $1,740 a year.

The sixth Congress of the International Association for testing Materials will meet in New York City from September 2 to 7. The headquarters of the congress are at 29 West 39th St., New York City.

The agricultural bill includes an appropriation of $80,000 on behalf of the Pennsylvania Chestnut Tree Blight Commission for the investigation and suppression of chestnut tree bark disease. The government is authorized to cooperate with the states, in-

cluding Pennsylvania, which has already appropriated $275,000 for the purpose.

Dr. Wilhelm Paul Gerhardt, of Brooklyn, N. Y., has given a collection of books, numbering 275 volumes, to the sanitary and biological department of the College of the City of New York, and a geographical collection of about 150 text-books and atlases to Teachers College, Columbia University. A third collection of several hundred volumes has been presented to the Illuminating Engineering Society of New York City.

A donor who wishes for the present to remain anonymous, has given the Chancellor of the Exchequer a sum of £10,000, of which £3,000 is to be handed to the National Museum of Wales, Cardiff, £2,000 to the University College of Wales, Cardiff, and £5,000 to the National Library of Wales, Aberystwith.

Under the will of Sir James Inglis, a former president of the Institution of Civil Engineers, the institution has received a legacy of £5,000, to be applied to its new building which is now in course of erection in Great George Street, Westminster, and to which he had during his lifetime contributed liberally.

*Nature* states that in response to a joint appeal made by the Royal Society of South Africa and the South African Association for the Advancement of Science to the Union government, a sum of £500 has been voted during the current financial year as a grant-in-aid for the purpose of assistance in scientific work in or relating to South Africa. A scheme for the administration of this and future funds available for the same purpose on lines similar to that of the Government Grant Fund of the Royal Society has been prepared by a joint committee representing the two above-mentioned societies.

The report of the American members of the commission appointed by the International Mathematics Congress, held in Rome in 1908, to study the subject of the teaching of mathematics in the several countries has been published for free distribution by the United States Bureau of Education.

A permanent memorial of the recent celebration of the two hundred and fiftieth anniversary of the Royal Society in the form of a volume of collotype facsimiles of the signatures of the founders, patrons and fellows of the society recorded in its first journal-book and the charter-book from 1660 to the present time is to be issued shortly by Mr. Henry Frowde. The work will contain a preface by Sir Archibald Geikie. The third edition, revised and rearranged, of "The Record of the Royal Society of London," is also announced.

We learn from the *Journal* of the American Medical Association that on June 1 the superior health magistracy of Saxony, the *Landesmedizinalkollegium,* was substantially extended and converted into a national health department. Its field includes the making of reports on matters of medical and veterinary interest, the advice of the government in the preparation and execution of sanitary laws, and the supervision and management of the scientific institutes subordinate to it.

Petroleum production in the United States in 1911 surpassed its own record made in 1910 by an increase of nearly 11,000,000 barrels. In 1910 the output was 209,557,248 barrels. The total production of the world also surpassed all previous records, amounting to over 345,000,000 barrels, and of this the United States produced more than 63 per cent. The value of this enormous output of oil in the United States for 1911 was $134,044,752, the average price being 60.8 cents a barrel. Final figures have been compiled by David T. Day, the petroleum statistician of the United States Geological Survey, and have just been made public in a statement issued by the survey. The increase for the year was caused principally by the gain in California, which was by far the largest producer, its output being over 81,000,000 barrels. Another factor in the increase was the discovery of oil at Vinton, La., and the comparatively new Caddo field in Louisiana also grew in importance. A find of high-grade oil at Electra, in northern Texas, was another notable event of the year. With a gain in production of nearly

11,000,000 barrels and with an increase in price at the end of the year, it is evident that an unusual condition in the oil market existed. The three commodities of general market value to be considered in connection with crude oils are gasoline, kerosene and residuals, the last suitable for fuels in the west and for lubricants and wax in the east. In the trade "naphtha" is the name generally applied to oils lighter than kerosene as distilled from crude oil, but by the public the term "gasoline" is applied to the light fraction of the oil suitable for internal-combustion engines. In fact, when crude naphtha is redistilled it is for the most part separated so as to yield gasoline and lighter or heavier kerosene. The demand for gasoline has become so imperative that little or none is now allowed to lower the safety of lamp oils; the latter have therefore greatly improved in character. In the production for 1911 California led with 81,134,391 barrels; Oklahoma took second place, with 56,069,637 barrels; Illinois was third, with 31,317,038 barrels; and Louisiana was fourth, with 10,720,420 barrels. The prices of the different oils varied greatly, ranging from 47 cents to $1.32 a barrel. Thus while the production in Pennsylvania was only 8,248,158 barrels, its value was $10,894,074, whereas Louisiana, which produced 10,720,420 barrels, received for it only $5,668,814. The greatest increases in production in 1911 were in California, 8,123,831 barrels; in Oklahoma, 4,040,919 barrels and in Louisiana, 3,879,025 barrels. The principal decreases were in Illinois, 1,826,324 barrels, and in Ohio 1,099,258 barrels. The following table of total production shows the general increase in production for the United States since 1901.

| | |
|---|---|
| 1901 | 69,389,194 |
| 1903 | 100,461,337 |
| 1905 | 134,717,580 |
| 1907 | 166,095,335 |
| 1909 | 183,170,874 |
| 1911 | 220,449,391 |

ACCORDING to *Terrestrial Magnetism*, preparations are being made, under the superintendence of Professor Tanakadate, to send out four parties for making a new magnetic survey of Japan, to be completed within two years. The same general scheme of work will be followed according to which the first survey of about eighteen years ago was successfully accomplished under Professor Tanakadate's direction. The issuing of the British Admiralty chart of lines of equal magnetic declination has been recently transferred from the Hydrographic Department of the Admiralty to the Magnetic and Meteorological Department of the Royal Observatory, Greenwich.

## *UNIVERSITY AND EDUCATIONAL NEWS*

IT is reported that Mr. P. A. B. Widener, of Philadelphia, has increased to one million dollars his gift to Harvard University for a library building in memory of his grandson, Harry Elkins Widener.

THE late Dr. John Dixon Mann, who occupied the chair of forensic medicine in the University of Manchester from 1892 until his death last April, bequeathed to the university the sum of £1,000. By resolution of the council, the money has been added to the special fund for the encouragement of medical research.

AT the University of California work has begun on a laboratory for the Citrus Experiment Station at Riverside, funds for this building and for the site on which it stands having been appropriated by the last legislature. The new laboratory will be thoroughly equipped, and will become headquarters for some of the work for advancing the interests of the orange and lemon industries heretofore carried on by the university at Whittier. The United States Department of Agriculture will cooperate with the university at Riverside, stationing there agricultural experts to study the problems of the citrus industry. Professor J. Eliot Coit has been appointed director of the laboratory.

*Nature* states that the establishment of the new university in western Australia is progressing satisfactorily, and the senate is open to receive applications for the filling of eight professorial chairs. Parliament has

voted an annual minimum endowment of £13,500 towards the administration and needs of the university, and the chair of agriculture has been fully endowed by the newly appointed Chancellor, Sir W. Hackett. Mr. H. Gunn, who carried out similar work in South Africa with success, has been appointed organizer of the university, and is now actively engaged in making preparations for the inauguration of the institution early next year.

Dr. B. E. Ray, at present of the Experiment Station and College of Agriculture, North Carolina, has accepted a position as professor of chemistry in the College of Agriculture and Mechanic Arts, Mayaguez, P. R. Special attention will be given to the development of courses in sugar chemistry.

Professor I. F. Lewis, Ph.D. (Hopkins), of Randolph-Macon College, Ashland, Va., has accepted a call to the assistant professorship of botany at the University of Wisconsin.

Mr. J. W. Merritt, assistant in mineralogy at Northwestern University, has been appointed instructor in geology at Dartmouth College.

At University College, Reading, Dr. S. M. T. Auld, lecturer in the chemical department of the Southeastern Agricultural College at Wye, has been appointed professor of agricultural chemistry, and Mr. John Goding, of the Midland Agricultural College, has been appointed research chemist in dairying.

H. Maxwell Lefoy has been appointed professor of entomology at the Imperial College of Science and Technology, South Kensington, London.

Professor Johannes Fitting, director of the State Botanical Institute at Hamburg, has been called to Bonn, as the successor of Professor Strasburger.

## *DISCUSSION AND CORRESPONDENCE*

### THE CORROSION OF IRON AND STEEL

To the Editor of Science: In the issue of Science for April 26, 1912, appears a review of a recent book, "The Corrosion of Iron and Steel," by J. Newton Friend, Ph.D. The review is signed "William H. Walker." The writer did not see this review at the time it was issued in Science, but his attention has just been called to it in a curious way. It appears that the review has been reprinted in pamphlet form for distribution as a commercial argument. The commercial argument is based upon the following paragraph from Professor Walker's review:

> It is a matter of regret that the author has been misled, as have also the reviewer and others, by giving credence to statements and data supplied by the American Rolling Mill Co., of Middletown, Ohio, which he publishes on pages 114, 250, 276 and 351, regarding the purity of this firm's products. For example, the material said to have the analysis published on page 114, as containing 99.954 per cent. iron, and which on page 276 is proposed as a standard for pure iron on which to base a corrosion factor, *was later found by the author himself, much to his surprise, to contain .172 per cent. copper.*

In the commercial reprint referred to, the portion of the quotation from Professor Walker's review which the writer has italicized, appeared in large block letters. There is only one inference that the reader of this pamphlet could form, which is that The American Rolling Mill Co., of Middletown, Ohio, is purposely putting copper into their material for some ulterior purpose.

The writer must express himself as being surprised, to say the least, that Professor Walker should have included in a review of a scientific book such a paragraph as this, based upon an analysis of a single open market sample which was manufactured in the early days of a new industry. Professor Walker must be well aware of the situation with respect to the elimination of copper from iron in the open hearth furnace, for under date of March 16, 1911, the writer wrote to Professor Walker as follows:

> In regard to the point you raise about copper in ingot iron, I can only tell you that at the time when the American Rolling Mill Co. first adopted the slogan in a trade way, of "99.94 per cent. pure," they had not established their chemical research laboratory and had paid no attention to the possible appearance of small amounts of copper in the iron, which came from the ore and selected

scrap which they, in common with other open hearth people, are obliged to use. They are now well aware that ingot iron carries normally about 0.1 per cent. of copper, although efforts are being made to reduce this, with some success. In the meantime, they are explaining that their "99.94" applies only to the usual impurities which have been discussed in relation to the manufacture of pure irons, such as carbon, manganese, sulphur, phosphorus and silicon.

Since the date of this letter, with the writer's advice, The American Rolling Mill Co. has reduced their purity guarantee to 99.84 in order to be certain to be on the right side with respect to the small unavoidable copper content. As a matter of fact, the copper content of the pure iron product now manufactured by The American Rolling Mill Co. is running normally 0.030 per cent. of copper, or better. The elimination of copper to this small percentage has been a matter that has required expert chemical engineering and very careful buying of raw material. At no time has The American Rolling Mill Co. ever introduced copper into their material except in the case of three experimental heats which were made under the supervision of the writer with the intention of determining what effect, if any, the introduction of small amounts of copper would have upon the qualities of the material. Subsequent tests showed that the introduction of copper into iron served no good purpose, and therefore the effort by The American Rolling Mill Co. to completely eliminate it has gone on with unremitting zeal.

From a commercial point of view, it is perhaps not to be wondered at that the attempt to manufacture an extremely pure iron on the same large scale of operation usual in steel manufacturing should have aroused the bitter enmity and active hostility of competing interests in this country. It is, however, certainly unfair to the efforts which have been made to establish the pure open hearth iron industry for the first time in the United States or, in fact, in the world, to have scientific literature distributed with the intent to produce the impression that the object of the manufacturer is not to produce a pure material but to load it with another metal for an ulterior purpose. If Professor Walker had taken the trouble to inform himself in regard to this question as late as April, 1912, he would have discovered that the normal heats of the pure iron made by The American Rolling Mill Co. do not contain more than .03 per cent. of copper, for any one interested in investigations along this line is welcome to obtain his own samples directly from the mill in which the material is being manufactured.

The total elimination of copper from a highly refined iron is not an easy metallurgical problem. The charge for the open hearth furnace, whether steel or pure iron is to be made in it, is normally a mixture of pig iron and selected scrap. If the object is to refine the mixture so as to produce a commercially pure iron, very special attention has to be paid to the amount of copper which may be carried in the raw material. Open market iron of the present day is likely to carry much more copper than was formerly the case. This is largely due to the fact that the introduction of lifting magnets for loading and unloading, has made available in the metallurgical arts, machine shop turnings and other useful sources of iron. From the conservation point of view, a movement of great value has therefore been developed by the use of the lifting magnet. Since, however, copper is not in the slightest degree eliminated in the refining processes of the open hearth furnace, unusual care has to be taken in selecting raw material, to see that it is not contaminated with copper. Owing to the increased uses of copper and bronze in bearings and other parts of machinery, even so-called "heavy melting stock" is likely to carry unknown quantities of copper. Nevertheless, by careful selection of scrap and pig iron used in the processes, and by paying more for selected materials, it is possible by the exercise of continuous vigilance to keep the copper content down to a minimum point.

It is a curious fact that while The American Rolling Mill Co. has been making every effort to fight copper and keep it at the lowest possible point, a number of the steel manu-

facturers have been deliberately adding copper to their steel, because it has been found that small amounts of this element caused the metal to be more insoluble in dilute acids. Most investigators agree that an acid test should not be made the sole basis of specification where resistance to atmospheric corrosion is required in the product, but nevertheless the fact that a metal can be shown resistant to the attack of mineral acids has been in the past, and is still, used as an attractive salesmen's argument.

The writer can not help regretting that Professor Walker should have included a paragraph in a scientific review, written in such a manner that it could be reprinted and used in a commercial contest with the object of producing a false impression.

Professor Walker in the same review takes occasion to regret that Dr. Friend had recommended this pure open hearth iron as a possible standard on which to base a corrosion factor. The writer has used this material in this way for some time, and the U. S. Bureau of Standards has recently acquired a quantity of the same metal in which the sum of the total impurities present, including the gases, is less than two tenths of a per cent.

It would appear to the writer that there is such a thing as professional ethics in respect to the scientific treatment of scientific books reviewed in a scientific journal, and that such reviews should not be used to introduce false impressions to be afterwards touted about the country as "salesmen's arguments." It is an unfortunate fact that the development of this new step in metallurgy, namely, the manufacture for the first time of commercially pure iron in the open hearth furnace, on a large scale of operation, should have called forth active enmity from so many unexpected quarters in this country.

Allerton S. Cushman

### ITONIDÆ VS. CECIDOMYIIDÆ

A note by Dr. E. P. Felt in Science for July 5 (p. 17) calls attention to a matter somewhat aside from the question of priority in nomenclature, but one which should not be disregarded by zoologists who are striving to attain stability and accuracy in the designation of taxonomic groups. There is much dissension among systematic zoologists regarding the status of Meigen's 1800 names for his genera of diptera which were rechristened by him in 1804. As is well known, the latter names were in common use for a full century and many workers are not in sympathy with those who advocate the adoption of the older, long-forgotten names. Whether the generic name *Cecidomyia* should become *Itonida* depends upon our acceptance of Meigen's earlier names, but no one should countenance the appearance in print of a family name "Itonidæ" in place of the proper form Itonididæ formed from *Itonida*. The international code is very specific on this point, stating that: "The name of a family is formed by adding the ending *idæ*, the name of a subfamily by adding *inæ*, to the root of the name of its type genus."

No one has seen fit to criticize this portion of the code, so far as the writer is aware, and students of these same Diptera have previously used in many instances the carefully formed family name Cecidomyiidæ even though this approaches dangerously near the tabooed "unpronounceable combination" which we are warned diligently to avoid. There has been much laxity in the use of carelessly formed family names by zoologists, particularly Americans, and the writer must plead guilty with the rest.

A little care on the part of systematists will serve to eliminate all such barbaric family names, and would add to the dignity of zoological nomenclature.

C. T. Brues

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## SCIENTIFIC BOOKS

*American Permian Vertebrates.* By Samuel W. Williston. University of Chicago Press, Chicago, Ill. 1911. Pp. 145 with frontispiece, plates I–XXXVIII, and 32 text figures.

This work from the pen of one of the most

eminent paleontologists is bound to attract attention from the clear anatomical descriptions of the forms under review and the conservative stand in the matter of conjectural speculations. The book, as the author says, "comprises a series of monographic studies, together with briefer notes and descriptions, of new or little-known amphibians and reptiles from the Permian deposits of Texas and New Mexico."

The sources of material are mainly three: the University of Chicago collection, made in recent years by field parties under the charge of Mr. Paul Miller or the author; earlier collections of the University of Texas, made by Professor E. C. Case; and finally the great Marsh collection in the Peabody Museum at Yale University, which proves an increasingly fruitful field for research as its varied treasures are brought to light. An interesting comment upon our knowledge of reptilian classification shows that the time is not yet ripe to attempt phylogenies of the groups other than the dinosaurs, crocodiles, phytosaurs, pterosaurs and rhynchosaurs, because we are less sure of them than we were a dozen years ago. "The more recent general classifications of the reptiles by Cope, Osborn, Boulenger, and others have offered suggestions of value, but they are by no means the real solutions of the reptilian and amphibian phylogenies. The recent classifications of Jaekel are not to be taken seriously." Certain morphological problems are discussed in the following pages and the author has given what seem to be the legitimate conclusions regarding the immediate relationships of the forms under discussion. The present work, however, is offered more as a contribution to our knowledge of ancient reptiles and amphibians, with such summaries and definitions, based chiefly upon American forms, as our knowledge at hand permits. The illustrations of the work throughout were made by the author.

A summary of the genera from the Texas Permian follows: Amphibia: *Lysorophus, Diplocaulus, Trimerorhachis* (apparently absent from the upper part), *Eryops, Cacops, Dissorophus, Aspidosaurus, Cardiacephalus.* Reptilia: from the uppermost beds, *Labidosaurus, Naosaurus, Dimetrodon;* from lower horizons, *Naosaurus, Dimetrodon, Clepsydrops, Varanosaurus, Trispondylus, Casea, Arœoscelis, Captorhinus, Diadectes, Seymouria,* etc., of which perhaps the most characteristic are *Labidosaurus* of the upper and *Cricotus* of the lower zones. Williston feels confident, however, that no definite line can be made between the two divisions, and that at present Clear Fork can be used in a general way to designate the upper, and Wichita the lower part of the Texas deposits.

Most of the important specimens come from two isolated deposits known as the Cacops and Craddock bone beds, the former of which is among the most remarkable deposits of fossil vertebrates known, especially when one considers the almost universal rarity of Permian remains.

The Cacops deposit lies in the valley of the Wichita in northern Texas about five miles west of the Vernon road, not far from Indian Creek, while the Craddock bone bed lies about six miles northwest of Seymour, also in northern Texas. The Yale material, on the other hand, comes mainly from New Mexico, all of the Marsh types coming from a deposit which Williston has designated the Baldwin bone bed.

The research of Professors Williston and Case is one of great promise, not only in the ultimate clarifying of our vision with regard to the anatomy and relationships of these ancient forms, but in revealing to us the actual stages of transition between two great vertebrate classes, the Amphibia and Reptilia. For his present book Professor Williston deserves our gratitude, and we look forward confidently to still more notable results when his researches shall have been completed.

RICHARD SWANN LULL

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*Microbiology, for Agricultural and Domestic Science Students.* By MARSHALL and others. Philadelphia, P. Blakiston's Son and Co.

In this work, of which Chas. E. Marshall

is editor, there have been brought together and collated as one, a large number of separate articles upon various phases of bacteriology, mycology and protozoology. The plan of the editor has been to have the various phases of these extensive subjects written up by such persons among our American scientists as have made them specialties, and then to have them edited and collated so as to constitute a logical whole. The result has been to produce a very remarkable book. Other books upon bacteriology, because of the many phases of the subject, have the fault of being one-sided, since each author inevitably knows his own phase of the subject best, and not only writes this part best, but is almost sure to exaggerate its importance. If he has been especially interested in the pathological side, pathological bacteriology becomes too prominent, while if he has worked himself upon soils, soil bacteriology becomes over-emphasized. By the plan of Marshall this becomes impossible, since each author is expected to write upon his specialty alone and to give it all the emphasis he can in the space allotted to him. Any error in perspective can thus come only from an error in the space allotted to each subject. In the balancing of the various topics presented in the work excellent judgment is shown, though perhaps, considering its immense importance, comparatively too little space is devoted to pathological microbiology. The result is a book treating of a large variety of subjects and all written by specialists who know their subjects so thoroughly that they can speak with authority. Under these conditions not only are the subjects efficiently handled, but there is a minimum of error, since no part of the book is the product of one writing except on familiar ground.

On the other hand the plan has the disadvantage of showing considerable inequality in the skill of the treatment of its different parts. Twenty different authors can not be equally successful in the presentation of their subject, and no amount of editing can avoid discrepancies in the manner and skill of treatment. Another result has been to produce a book of a size almost unmanageable for its original purpose. Designed as a text-book for agricultural and domestic science students, it has become what might almost be called a collection of monographs. It is a book of 700 pages, of large size, small print, narrow spacing and with matter form condensed to the smallest possible number of words, and together forms a bulk of material practically hopeless to expect an ordinary college class to master. As a book of reference it is invaluable, but the substance is too great to expect it can be handled by any class. But recognizing these limitations, the book becomes a most extremely valuable addition to the literature of bacteriology, perhaps the most valuable single publication that has yet appeared. The various authors are particularly to be thanked for the time and care taken in what must at best be a work of love.

A better idea of the scope of the work may be obtained from the following condensed outline:

Part I. Morphology and culture of microorganisms, including molds (Thom), yeasts (Bioletti), bacteria (Dorset) and protozoa (Todd).

Part II. Physiology of microorganisms (Rahn).
- Nutrition and metabolism.
- Physical influences.
- Chemical influences.
- Mutual influences.

Part III. Applied microbiology, including microbiology of the air (Buchanan), of water (Harrison), sewage (Phelps), the soil (Lipman), of milk (Stocking), of butter and cheese (Hastings), of special dairy products (Stocking), of desiccation of foods (Buchanan), of preservation by heat (Edwards), by cold (MacNeal), by chemicals (MacNeal), food poisoning (MacNeal), alcoholic products (Bioletti), vinegar (Bioletti), other fermented products (Bioletti), vaccines (King), antisera and other products (King), diseases of plants (Sackett), methods and channels of infection in man and animals (McCampbell), immunity and susceptibility (McCampbell), microbial diseases of man and animals by various authors and control of infectious diseases (Hill).

This outline gives an idea of the comprehensiveness with which the subjects are

covered; only an examination of the work itself can show the method of treatment and the completeness with which the many phases of the many-sided microbiology are treated.

The book is well printed, though the type is small and the pages look crowded. There are 128 figures in the book, of widely varying grades of merit. The editing is well done and the errors are few. Whether or not the book will prove useful in classes it will be indispensable for a bacteriologist's book shelves.

H. W. CONN

## SPECIAL ARTICLES

### STUDIES ON THE WILT DISEASE, OR "FLACHERIA" OF THE GYPSY MOTH

FOR the past six months we have been engaged in a study of the cause and nature of the wilt disease of gypsy moth caterpillars. The disease, so far as we are able to learn, is similar to the one attacking the nun moth (*Lymantria monacha* L.) in Germany. But although the investigations carried on in that country have led usually to negative results so far as the causative agent of the disease is concerned, still the work has been in the main of a scientific character. We are speaking of such work as has been done by Escherich, Prowazek and Tubeuf. This is more than can be said of some of the attempts made in this country and we thoroughly agree with Escherich,[1] who says, in speaking of a recent paper by Mr. William Reiff[2] "Es fehlt also so ziemlich alles, was zu einem wissenschaftlichen Beweis für die behaupteten Zusammenhänge gehört."

Our first attempts were confined to a search for protozoa in the tissues of the caterpillars, and while dissecting and examining these many were seen to contain certain polygonal bodies clustered around their tracheæ. These bodies have a very high refractive index and resist all stains, with the exception of iodine, in which they take on a uniform tint. No definite internal structure can be detected, however, and it finally dawned upon us that we had a case here analogous to the one in the nun moth. Bolle[3] first found these bodies in sick silkworms, and Tubeuf later discovered them in nun moth caterpillars afflicted with the "Wipfelkrankheit," a sickness the symptoms of which seem to be in many respects similar to those of the gypsy moth wilt. Wachtl and Kornauth[4] were the first to realize that the so-called polyhedral bodies have a diagnostic value, for caterpillars afflicted with "Wipfelkrankheit" are never free from them. Wolff[5] thinks that they are reaction-bodies having nothing to do with the cause of the disease. This he believes to be due to the presence of certain bodies called "Chlamydozoa" by Prowazek. Wolbach and McKee,[6] however, have since shown that the "Chlamydozoa" are products of mucous secretions under pathological conditions and not organisms. Escherich and Miyajima[7] resumed the study of the polyhedral bodies and besides presenting many original observations, confirmed Wachtl and Kornauth's results as to the high diagnostic value of these crystal-like aggregates. The figures and descriptions given by the former authors are very good, and we have no reason to doubt that the bodies which we find in the gypsy moth are precisely the same. At the beginning of the infection these polyhedral bodies are few in

[1] *Naturwiss. Zeitschr. für Forst und Landwirtschaft,* Heft 2 u. 3, Feb.–Marz, 1912, p. 85.

[2] "The Wilt Disease, or Flacherie of the Gypsy Moth," published by the Bussey Institution of Harvard University, 1911.

[3] "Der Seidenbau in Japan, nebst einem Anhang: Die Gelb-oder Fettsucht der Seidenraupe, eine parasitäre Krankheit," Budapest, Wien und Leipzig (Hartlebens Verlag), 1898.

[4] "Beiträge zur Kenntnis der Morphologie, Biologie und Pathologie der Nonne," *Mitteil. forstl. Versuchswesen Österreichs,* Heft XVI., Wien, 1893.

[5] "Uber eine neue Krankheit der Raupe von *Bupalus piniarius* L.," *Kaiser Wilhelm-Institutes für Landwirtschaft in Bromberg,* Band III., Heft 2, 1910, s. 69–92.

[6] "The Nature of Trachoma Bodies," *Journ. Med. Research,* n. s., Vol. XIX., No. 2, pp. 259–264, April, 1911.

[7] "Studien über die Wipfelkrankheit der Nonne," *Naturwiss. Zeitschr. für Forst und Landwirtschaft,* Heft 9, 1911, pp. 381–402.

numbers, but later they surround the tracheæ in curious cyst-like clusters. Still later the other cells become filled up with them and finally, when the caterpillar dies and disintegrates, they escape into the body fluids. The polyhedral bodies, to be sure, behave as crystals, but, not finding at the time anything of interest in the tissues, we gave them considerable attention, confirming Escherich's various chemical tests and staining reactions. That the polyhedral bodies might be organisms, perhaps distantly related to the microsporidians, seemed inconceivable; still their curious cyst-like arrangement around the tracheæ helped much towards concentrating our studies upon them. They revealed nothing, however, which could in any way be associated with parasitism and were finally abandoned as mere reaction-bodies, possibly urates. They react fairly well to the murexid test, giving all the color reactions except the last one. Why we have been unable to obtain this last reaction we are at present unable to say. We find that these bodies can be readily centrifuged out from sick and dead caterpillars and in quantities sufficient for purposes of chemical analysis, and we hope to be able to give a more intelligible account of them later. Nevertheless, as has always been supposed, the polyhedral bodies seem to have some significance, for after using good light and very high magnification small wriggling organisms were observed in the fat cells and other cells at such times as the polyhedral bodies were clustered around the tracheæ. These moving organisms were stained and found to be bacteria. From this time on we pursued the work along bacteriological lines and we believe have been able to demonstrate the etiological connection of these bacteria with the disease.

Living caterpillars are the only ones which can be treated with fixing fluids for sectioning. When a caterpillar dies of the wilt the degeneration of the tissues is so rapid that it is impossible to handle it. When touched, it goes all to pieces and therefore can never be used for histological work. Some of the sectioned material showed that hardly any of the tissues failed to reveal the presence of this bacterium. It was found in great numbers in all parts of the intestine and in many caterpillars appeared to be in the act of perforating its walls. The fat cells seem to be particularly liable to attack, which probably accounts for the saponified nature of the fat of sick caterpillars. The musculature, ganglia, testes, ovaries, œnocytes and other cells are also heavily parasitized. In fact, as previously stated, nothing seems to be exempt, since the infection extends even to the hypodermal cells. Some larvæ show a heavier degree of parasitism than others, while a certain number apparently not diseased may be free from the bacteria.

The organism in question is very small, having a diameter of only .51 $\mu$–.85 $\mu$. It resembles *Pneumococcus* very closely except that it is motile, progressing in a gyrating manner. For this reason, and because it seems to be an undescribed form, we have named it *Gyrococcus*. A brief technical description of it is given at the end of this paper.

Smears of dead larvæ were now studied and after making the smears very thin and using Grübler's Giemsa or Delafield's hæmatoxylin with eosin, the *Gyrococci* were more clearly revealed. Owing to their minuteness it is almost impossible to see them in thick smears. They are also apt to be obscured by the polyhedral bodies, which are very abundant in dead material, so that smears must be thinned out with sterile water in order to separate these bodies. Then only can the *Gyrococcus* be recognized easily under the 2 mm. oil immersion in combination with the compensating 12 or 18 ocular. In material which has been dead a long time many different species of septic bacteria accumulate, but caterpillars which have just died are fairly pure except for the *Gyrococci* which are present in large numbers.

In order that the non-pathogenic forms might give us as little trouble as possible, we inoculated sterile veal tubes with the fat of living infected material. These tubes were kept in an insectary where the temperature fluctuated during May, June and July between 80° and 95° Fahrenheit. We thought that

such a temperature might be favorable for growth, because we found that a certain number of our caterpillars died from "flacherie" throughout the winter whenever we allowed the temperature to rise sufficiently in the insectary. Furthermore, our field experience later in the season clearly demonstrated to us that more caterpillars die of "flacherie" on a warm than on a cool day. In twenty-four hours the veal tubes became turbid. They were examined and *Gyrococcus* was found to be present in great numbers, together with a few other forms. These were then isolated on agar and after about forty-eight hours, small, round or oblong, smooth, cretaceous colonies were found, which showed again after microscopic examination that our bacterium grows on agar. Other sterile tubes were inoculated with these pure colonies and after twenty-four hours more a pure growth was obtained. These tubes remained odorless from the beginning of the growth to the time when the nutriment became exhausted. The first impure set of tubes had an odor due to the presence of septic forms.

For inoculation purposes, the fact that larvæ looked healthy externally was not considered to be sufficient evidence that they were free from infection, for a larva may appear reasonably healthy and feed normally with a greater or less number of germs in its system. As a matter of fact, if the temperature and food conditions are favorable a larva may pass through its sixth moult, pupate and even transform into a moth, carrying a number of *Gyrococci* along during the process. External conditions have a great influence on the rapidity with which the *Gyrococcus* multiplies within its host and for that matter within the veal tubes also. Hence, owing to the apparent feeble virulence which the *Gyrococcus* has when few in numbers, the external appearance of a larva means absolutely nothing. The blood, however, affords a very excellent diagnostic medium. The caterpillars were therefore tapped and only those were used in the experiments which were found to be free from the *Gyrococcus*. The blood was usually tapped from one of the prolegs. This operation can be repeated on the same larva at intervals of a day or two without injuring it. After tapping the blood each caterpillar was isolated in a separate, clean box and fed only with food which had been carefully selected and washed.

All the caterpillars which were pronounced free from infection after the blood had been carefully examined for *Gyrococcus* were divided into four lots. Each lot was used for an experiment with a pure culture of the bacterium. Twelve caterpillars were inoculated in the proleg and twelve in the dorsal vessel. Four controls accompanied each one of these lots. Twelve caterpillars were fed with the pure culture from a sterile pipette and fourteen were fed with leaves smeared with the culture.

The table given below comprises the results of one series of our experiments. The rate of death at each day succeeding the inoculation or the feeding is represented. Since at this time all of the caterpillars were full grown several of them pupated.

TABLE

The first and second days were very hot.
The third and fourth days were very cool.

| Number of Days After Inoculation or Feeding | No. of Caterpillars which Died | | | |
|---|---|---|---|---|
| | Inoculation in Proleg | Inoculation in Dorsal Vessel | Fed from Pipette | Fed with Smeared Leaves |
| First day | 3 | 3 | 3 | 6 |
| Second day | 2 | 2 | 4 | 2 |
| Third day | | | | |
| Fourth day | | | | |
| Fifth day | 1 | 1 | 3 | 2 |
| Sixth day | 2 | 1 | 1 | |
| Seventh day | | 1 | 1 | 2 |
| Eighth day | | | | 1 |
| Ninth day | | 1 | | 1 |
| Tenth day | 1 | | | |
| Eleventh day | 1 | 1 | | |

It will be seen from the table that ten caterpillars out of the twelve inoculated in the proleg succumbed to the disease. Two out of the ten died in the pupal stage. Of the surviving two, one is still a pupa at the time of writing and one emerged. Ten out of the

twelve inoculated in the dorsal vessel died, the remaining two are still pupæ. All of the deaths were typical of "flacherie." Of the two lots used for feeding experiments all died without a single exception. All of the controls survived and pupated, and some of these have already become moths.

It will be noticed that some caterpillars seemed to be more resistant than others or perhaps they may not have received as large a dose and consequently were longer in dying. The feeding experiments were particularly successful, all of the caterpillars succumbing within nine days with the typical symptoms of "flacherie." We performed several series of experiments similar to the ones outlined above and the results in general agreed very well with those of the described series. That the feeding experiments were more successful than the others may be accounted for in one of two ways. First, in feeding we evidently gave them a larger dose, for our inoculating needles are very fine indeed to avoid injury to the caterpillars and consequently the number of *Gyrococci* introduced by inoculation must be considerably less than the number introduced by feeding. Second, the infection naturally enters by way of the mouth with the food, for sectioned material shows that in some cases while none of the cells are as yet attacked, the proctenteron is nevertheless heavily infected. As soon as a caterpillar died it was carefully examined and those which died as a result of the two methods of feeding were found to be much more heavily infected than those which died after the inoculating experiments, although in the latter case the number of bacteria was great enough to have caused death.

Whenever any of the control experiments died, which did not often happen, we could always trace it to carelessness on our part, for careful reexamination of our original blood slide sufficed to show that the *Gyrococcus* had been present and had been overlooked. In nearly all cases we were successful in obtaining moths from our controls.

It was very interesting to see the influence which the temperature exerted on these experiments, for on hot days three times as many caterpillars died of the disease as on cool days. Two such cool days are represented in the table by the third and fourth dates, when not a single caterpillar died in any of the experiments. We do not mean to say that temperature is the only factor which is of importance, but its activating power is as striking in the laboratory and insectary as it is in the field. For this reason we believe caterpillars in their first, second and third instars usually escape not because they are small, but because when the caterpillars are still in these stages the weather is comparatively cool and the food is still plentiful even in heavily infested localities. Bad food or lack of food also bears an intimate relation to the period of life at which a caterpillar may die of the disease. Poor or insufficient food must obviously lower a caterpillar's vitality and weaken its powers of resistance.

In each series of inoculating experiments a few caterpillars survived and pupated. Some died with the disease during this stage, while a few transformed. When the latter were examined the body fluids and tissues of the moths were found to be full of *Gyrococci* and the ovaries were also infected, showing the great possibility for the transmission of the disease to the offspring through the eggs. In fact, there are two things which suggest that "flacherie" may be transmitted in this manner. First, caterpillars which are reared from eggs and kept isolated contract the disease independently of one another. Second, we have found the ovaries of material used for experimentation as well as some of the ovaries dissected from moths caught in the field to be infected. In the males, however, we have been unable thus far to find *Gyrococcus* either in the seminal fluids or in the spermatozoa. Hence we conclude that the transmission of the disease is probably accomplished through the eggs, although up to this time we have not had time to section any of these.

To exclude the possibility of having really inoculated an ultra visible virus together with the *Gyrococcus*, a large number of caterpillars

were prepared (blood tested) for inoculation and feeding with material passed through the Berkefeld filter. Those fed and inoculated with the filtered culture all survived, while those which were treated in the same manner with the unfiltered culture all died.

It might be well to call attention to the fact that caterpillars fed with the juices of those which die of the disease succumb as rapidly as do caterpillars fed with the pure culture. The disease is probably spread in nature by the juices of disintegrated caterpillars flowing over the leaves which are later eaten by others. We have found *Gyrococcus* in the fæces, and the fact that such excretions are washed over the leaves by rain seems to show that the disease may also be spread in this manner.

What economic value the "flacherie" disease may have in combating the gypsy moth, we are not prepared at present to say. We have no experimental evidence whatsoever that the disease may be air-borne, as claimed by Mr. Reiff, although, of course, we do not wish to exclude such a possibility. Our experiments seem to show, first, that it takes a good many *Gyrococci* to kill a caterpillar and, second, that conditions must be favorable for the disease or, putting it in another way, unfavorable to the caterpillars by lowering their vitality; so it seems very improbable that any such methods as are at present utilized for the artificial spread of "flacherie" will be of any avail.

The present race of gypsy moths in Massachusetts seems to be permeated with the disease, for we have been unable to find a single locality where "flacherie" is not accomplishing some good. Professor Wheeler has made many observations and he agrees with us as to the above statement. He has been out with us on many of our inspection trips and has likewise noticed the great influence which temperature and other external conditions seem to have on the disease. Since we can not control external conditions and since the disease accomplishes so much good in nature and is probably increasing year by year, and since it is transmitted from mother to offspring, we may have to content ourselves with its natural havoc.

In conclusion we append a description of the peculiar bacterium which we believe to be the specific cause of the wilt disease, with a discussion of its generic characters.

*Gyrococcus flaccidifex* gen. et sp. nov. Cells in free state spherical, becoming slightly oblong just before division. Division in one direction of space only. After division each half may be spherical or may come to an abrupt tip, assuming a more or less heart-shaped appearance. Frequently the two halves are unequal; one half may be spherical while the other may be more or less heart-shaped, or slightly oblong. If cells remain connected after fission, chains of three or four are formed. A chain exceeding four units has never been observed. Size of single cells; diameter $.51\,\mu$–$.85\,\mu$. No evidences of endospore formation. Capsule distinct. Organs of locomotion present. Gram-negative. Colonies on agar spherical or oblong, small (diam. .5–1 mm.), smooth, cretaceous.

All of the above size and form characters may vary somewhat, especially in *Gyrococci* under cultivation. They are somewhat larger after long culture on artificial media and the formation of chains of three or four is much more frequent. Indeed, the formation of chains has never been observed in the fluids or tissues of the host. We are certain that the *Gyrococci* are motile, for when all air currents are excluded from the slide with sterile vasaline and everything is quieted down as much as possible, they gyrate across the field of vision in all directions and with remarkable rapidity. Furthermore, their behavior in the living cells is such that no one would mistake their activities for Brownian movement. Flagellar stains were tried, but so far without success.

It will be seen from the above description that *Gyrococcus* resembles *Pneumococcus* more closely than any other form. Its motility and its negative reaction to Gram's stain are, however, sufficient, we believe, to exclude it from that genus and hence, owing to its peculiar gyrating mode of locomotion we have

proposed for it the generic name of *Gyrococcus*, and owing to the striking flaccidity of caterpillars dying as a result of its presence, we have selected the specific name *flaccidifex*.

A much more detailed account of our work will be published later.

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July 22, 1912

THE PROLIFICNESS OF GAMBUSIA

On June 3, 1912, there was received at the aquarium of the Bureau of Fisheries in Washington a lot of top minnows (*Gambusia affinis*) from the lower Potomac River, comprising several males and about 90 females heavy with young. On June 7, the expulsion of the young began, and by June 27 all the females had become spent.

The viviparity, the relative scarcity of males, the great disparity in the size of the sexes and various other facts regarding this species are well known, although I have been able to find no adequate account of some of the most interesting phases of its life history. The principal object of this note is to call attention to the remarkable prolificacy of this little fish, which probably has few parallels among viviparous vertebrates.

The young are expelled in lots of 1 to 5 at short intervals, and the entire brood is delivered in the course of one and a half to three hours. The young swim readily and actively immediately after expulsion. Their length at birth is 8 to 9 mm. The progeny of one mother fish forms a very sizable school; and it was this that suggested the taking of an accurate family census. On one moribund fish 5 cm. long, that had apparently succumbed from inability to expel her young, a Cesarian operation was performed, and 33 living and 51 dead embryos were taken. Other fish 4.5 to 5 cm. long were killed, and counts of the fully developed young were made, the numbers ranging from 85 to 134, the average for all fish examined being exactly 100.

The production of two broods in a season has been suggested by the fact that young are born in spring and also in late summer. This may indicate only a protracted breeding season; but in the fish now under observation there are conspicuous ova which might easily reach full development in six to eight weeks, and fish from the same locality which I examined 22 years ago contained large embryos on August 11. If there are later broods, as I am now inclined to believe, this might account for the marked difference in the average number of young ascertained to be produced by fish observed in June, 1912, and by fish of same size and from same stream in August, 1890, the average for the former being 100 and for the latter 24 (the extremes being 18 and 30). Inasmuch as a second lot of ova would have to attain a certain degree of development while the abdomen was crowded with embryos, it might easily happen that fewer eggs would come to maturity and be fertilized than in the case of the first brood. This may afford a clue to the statement of the late Professor Ryder that "viviparous forms like the cyprinodonts have comparatively few ova, and the number may be as few as 15 or 20 in such a form as *Gambusia*."[1]

An interesting observation is the cannibalistic tendency of the parent fish. Notwithstanding other food was present, the adults showed a pronounced fondness for their offspring, and began to feed on them soon after they were born. In order to save the young, it was necessary to retain the adults in a wire cage through the meshes of which the young could escape into the aquarium. One fish 4.8 cm. which was transferred to a special receptacle produced 85 living, healthy young, and devoured about half of them during the second night. Another fish that was under observation chased assiduously her first born as soon as it was expelled.

H. M. Smith

Washington, D. C.,
July 1, 1912

[1] Bull. U. S. Fish Comm., 1883, p. 196.